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13. Materials for investigations were selected and purchased. The results of structural characterization of ultrafine-grained Al6061+10%Al_2O_3 composite processed by equal-channel angular pressing are presented. In order to extend a range of industrial applications of ultrafine-grained Al alloys and composites, the ECA pressing die for processing the specimens of 40 mm in diameter and 150 nm in length was designed.

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INTERIM REPORT

A. The Cover Page

(1) Research and Application of Advanced Superplasticity in Ultra-Fine Grained Aluminum Alloys and Compositions.
(2) Professor R.Z.Valiev
(3) Professor V.S.Zhernakov
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B. Body of the Report

During preparation of this project and in the first month the following activities were fulfilled.

Materials for investigations were selected and purchased. They are aluminum alloys of composition Al-5%Mg-2.2%Li-0.1%Zr, Al-9%Zn-3%Mg-2.3%Cu-0.6%Mn-0.13%Zr as well as the aluminum based composite Al6061+10%Al_2O_3. These materials are selected to demonstrate the potential for severe plastic deformation techniques to achieve high strain superplasticity in large billets with ultrafine-grained (UFG) structures from typical commercial Al-alloys and composites.

During this period we could process ultrafine-grained structures by equal-channel angular (ECA) pressing in the billets of the composite Al6061+10%Al_2O_3 having 20 mm in diameter and 100 mm in length. These samples were pressed through the modified die using an ECAP facility in which the intersection angle of two channels was 90 grad. Samples were subjected to multiple-cycle pressing at the temperature 400°C (8 passes) and 200°C (2 passes). Structural characterization of the samples was performed on a transmission electron microscope JEM-100B. The invesigtions showed that resulting samples out of Al6061-composite were characterized by homogeneous structure of a matrix alloy with a mean grain size of 0.7 μm. The Al_2O_3 ceramic powders in UFG composite had equiaxed shape with a size from 2 μm to 10 μm. The precipitates with a size of 20-100 nm were observed as well. The processed samples of the Al6061+10%Al_2O_3 composite were delievered to Professor Langdon's laboratory (USC, LA) for thorough testing of superplastic properties.

In order to extend a range of industrial applications of UFG Al alloys and composites the ECA pressing die for processing specimens of 40 mm in diameter and 150 mm in length was designed. The fabrication of the new die would allow to use large billets to demonstrate a possible utilization of HSR superplasticity in UFG aluminum alloys and composites for production of light and high-strength articles of complex shape.

During this period a paper entitled "Strengthening and Grain Refinement in an Al-6061 Metal Matrix Composite Through Intense Plastic Straining" by R.Z. Valiev, R.K. Islamgaliev, N.F. Kuzmina, Y Li and T.G. Langdon was prepared and submitted to Scripta Materialia.

During the next period (five month) we plan to improve the ECA pressing processing regimes (routes, temperatures, strain rates) to fabricate the smallest grain sizes in the selected

aluminium based alloys and composite. A range of materials under research will be extended as well. Bulk samples of the UFG Al2009+15%SiC composite and the Al-9%Zn-3%Mg-2.3%Cu-0.6%Mn-0.13%Zr alloy will be fabricated to study their microstructure by TEM and X-ray and enhanced superplastic properties. The mechanisms and origin of high strain rate superplasticity in UFG aluminium based alloys will be investigated. Special attention will be paid to study of structure evolution during superplastic deformation, definition of morphology and a role of disperse particles.

In the rest period the fabrication of the new die for ECAP processing of large billets will be completed due to a partial support of the contract. First pilot articles of complex shape will be made using high strain rate superplasticity.